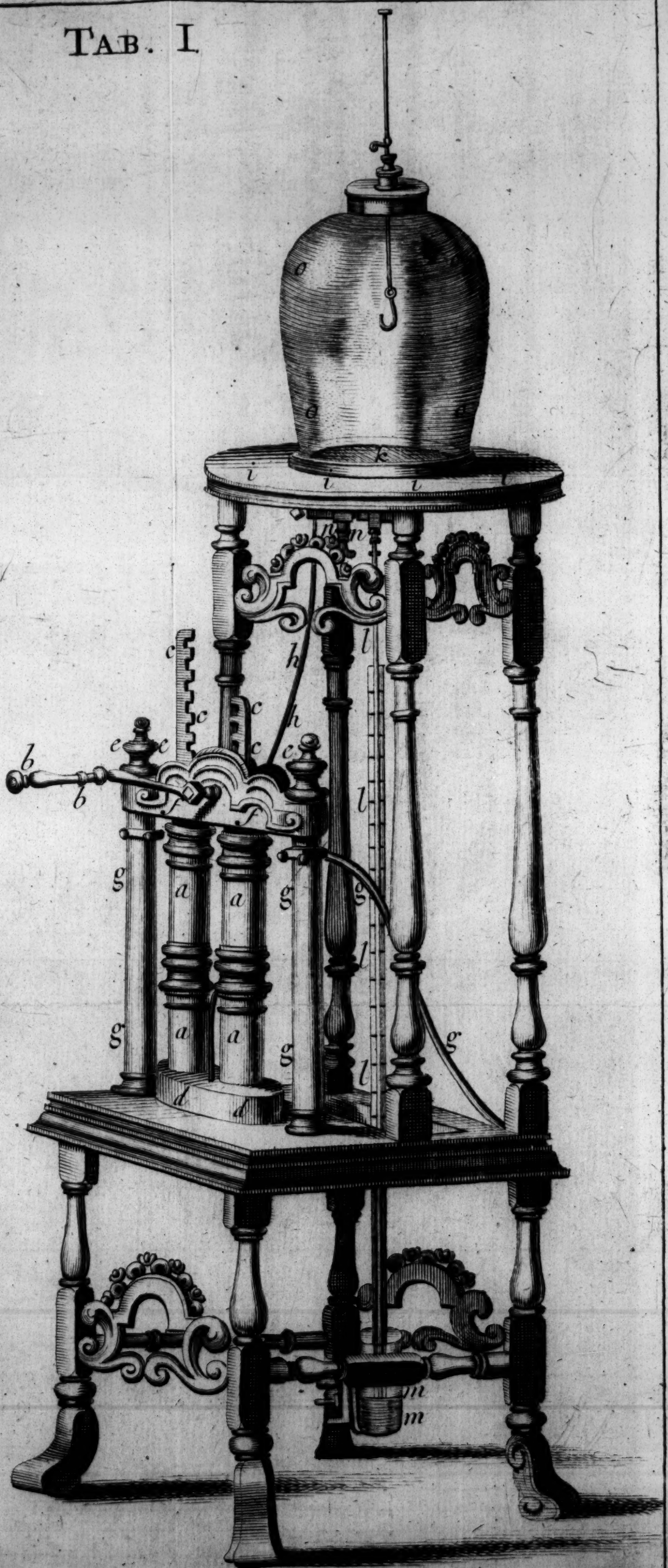


TAB. I.





TABU. II.

Fig.

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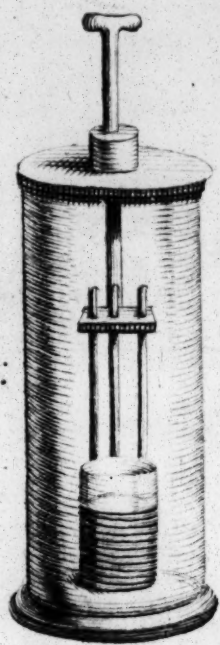


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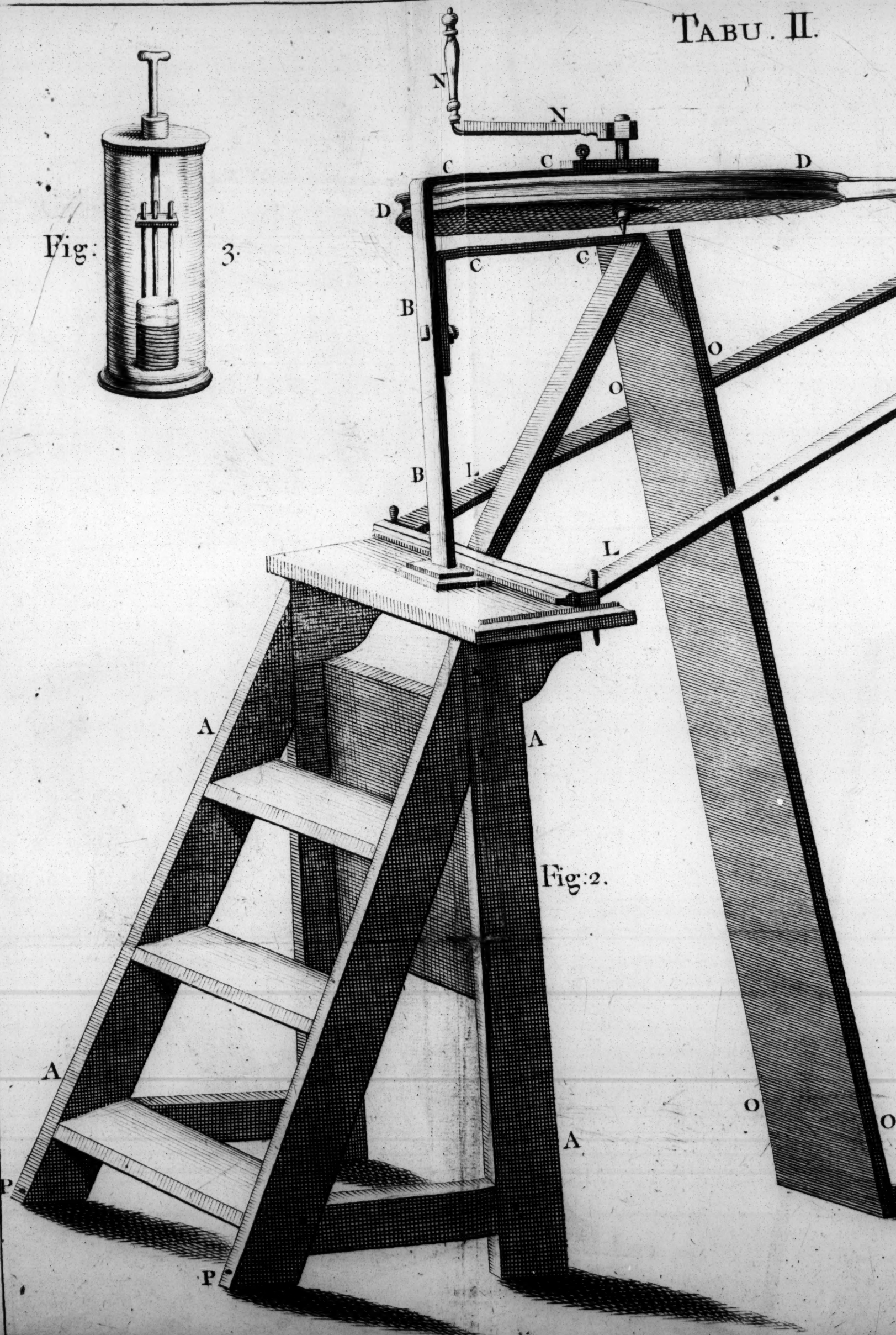


Fig:1.

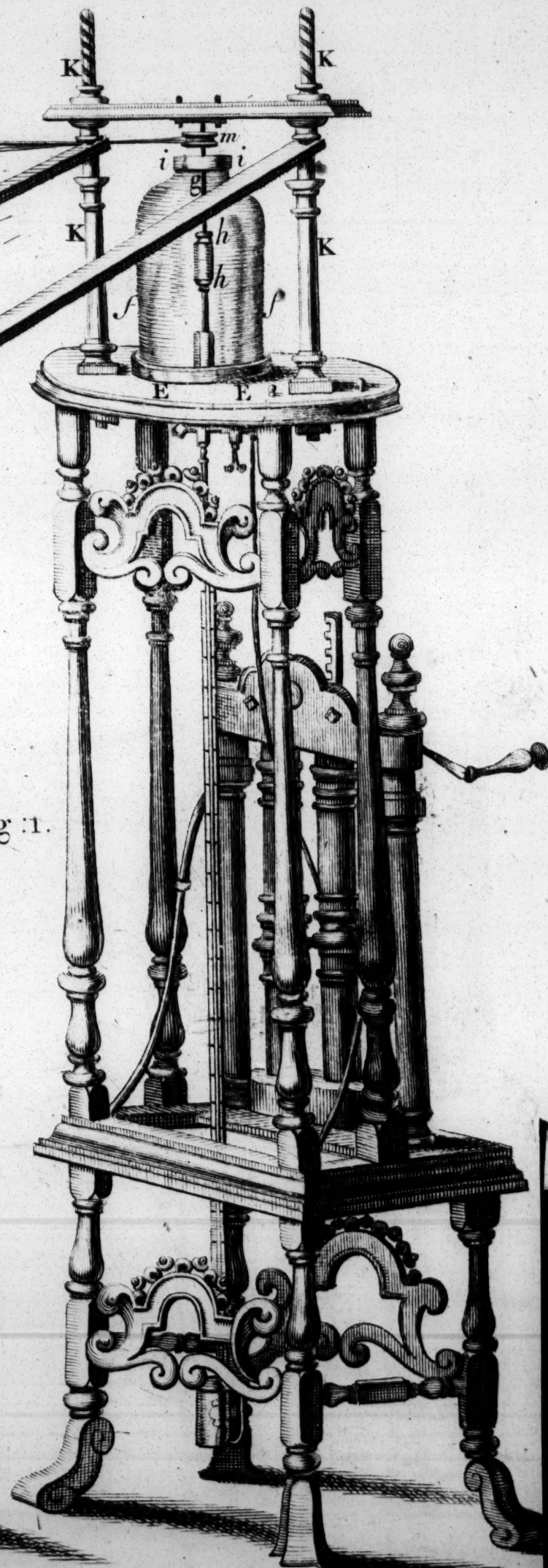
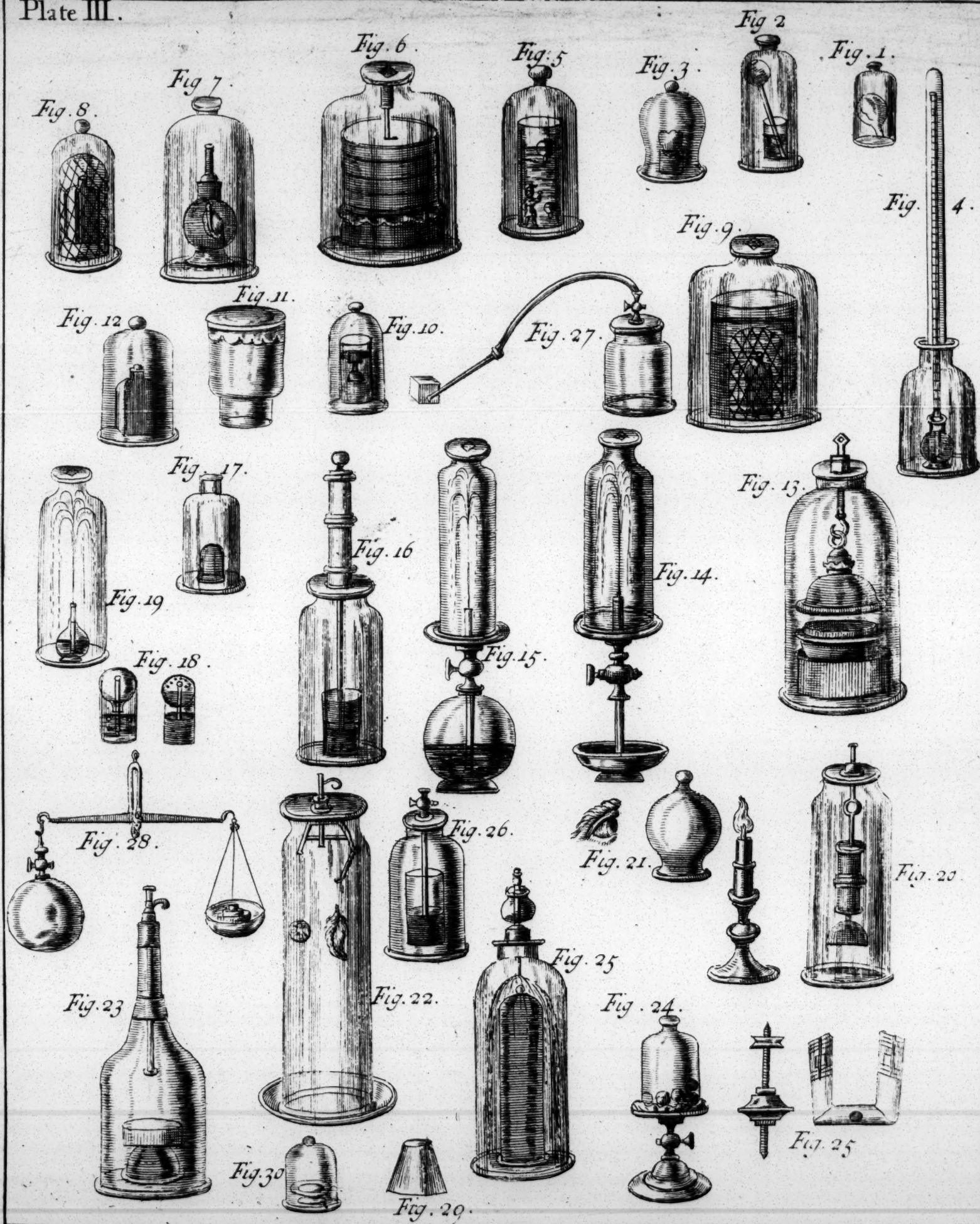
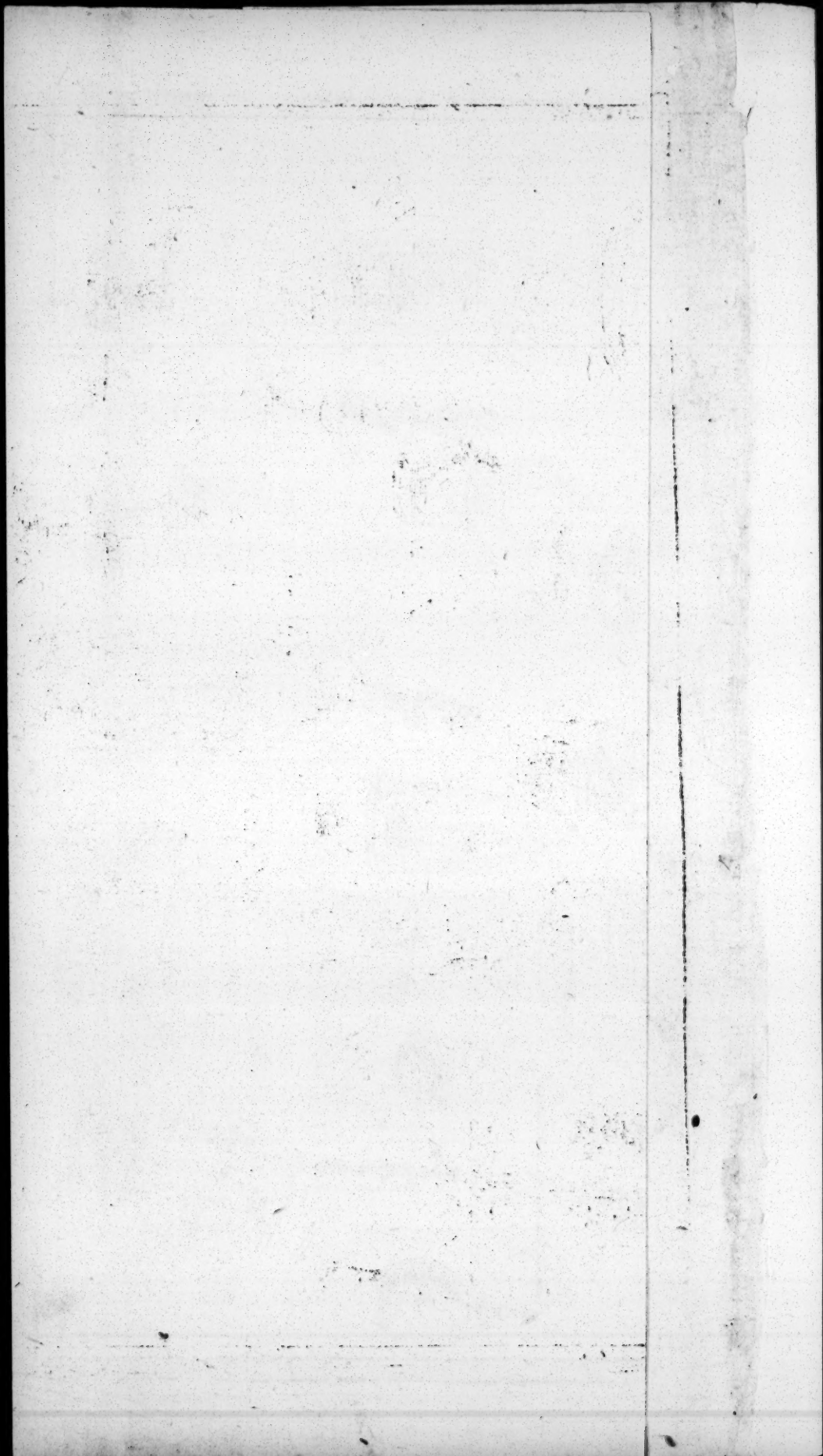




Plate III.







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5

# DESCRIPTION OF THE AIR-PUMP,

According to the late

Mr. *Hawksbee's* best and last Improvements ;

With the manner of making Fifty of the most curious  
Experiments upon it: The Figures of the Air-  
Pump-Glasses, and all the Machines belonging to  
it, being curiously engraven in Copper Plates.

---

By *WILLIAM VREAM*, Pneumatical  
Instrument-Maker.

---



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L O N D O N :

Printed by *J. H.* for the Author, and Sold only by himself at  
his House in *Earl-street*, near the *Seven Dials*, within two  
Doors of the *Royal Oak*; and Mr. *Richard Bridger*, at the  
upper End of *Hind-Court*, *Fleet-street*, 1717.



DISPERITION  
OF THE  
AIR-PUMP

Ascribed to the late

the Honorable's self and his improvements

the name of making of the most curious  
instruments upon it. The figures of the Air-  
Pump-Glass, and all the Machines belonging to  
it, being carefully engraved in Copper-plates.

BY WILLIAM W. R. A. M. Philosophical  
Instrument-Maker.

TO BE HAD OF  
the Author, at his Shop, in the Strand, near the  
Royal Exchange, and of all the Booksellers in  
London, and the principal Booksellers in the  
Provinces.



## ADVERTISEMENT.

**A**ir-Pumps, single and double, with all their Apparatus as hereafter describ'd, with some new Improvements.

Engines for condensing the Air, with Syringes for injecting the Air forcibly into any Vessel, as also Syringes for anatomical Injections, with all their Pipes and Apparatus.

Little Pumps for Cupping, of Brass or Silver, with Scarificators, that is, Instruments for making Ten, Thirteen or Nineteen Incisions at a time; together with Cupping-Glasses of all Figures and Sizes.

Cupping-glasses to be us'd with the flame of Spirit of Wine, with small Lamps for that purpose.

Blow-Pipes of all sorts, with or without Valves.

Hydrostatical Balances for trying the different specific Gravities of all Fluids, Metals and Oars, &c.

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Fountains of Glass, or of japan'd Copper, which throw up the Water to a great height in different Figures.

Machines for shewing the use of all the Mechanical Powers; and Models of any Engine for raising Water, or any other use, to be made upon a sight or description of the propos'd Engine.

Wind-guns, Papin's Digesters; Apparatus for performing such Feats, as are pretended to be the Effects of a prodigious Strength, whereby any Man may pull against two Horses, raise vast Weights, and break a strong Rope.

All these are Made and Sold by Richard Bridger, (who was Apprentice to the late Mr. Hawksbee, F. R. S.) at the upper end of Hind-Court, Fleetstreet; and William Vream Pneumatical Instrument-Maker, at his House in Earl-street near the Seven Dials, within two Doors of the Royal Oak.



A

# General Description OF THE AIR-PUMP.

THE *Air-Pump* (represented in *Plate I.*) consists of two Brass Barrels or Cylinders, as represented by *a a a a*, Twelve Inches in height, and two their Diameters within. The Suckers or *Emboli*, are rais'd and depress'd, by turning the Winch *b b* backward and forward. The Winch is fasten'd to a Spindle, that passes thro' a Lantern, whose Pins perform the Office of Cogs; for in its Motion, they lay hold on the Teeth of the Racks *c c c c*, and so reciprocally as one is depress'd, the other is elevated: By which means the Valves, which are made of limber Bladder; and fix'd on the upper Part of each Embolus, as well as at the bottom of the fore-mention'd Cylinders, perform their Offices mutually of exhausting and discharging the same Air, taken from the Recipient or Receiver on the Plate of the Pump. And when the Recipient comes to be pretty well exhausted of its contain'd Air, the pressure of the outward Air on the descending Sucker is nearly so great, that



that the Power requir'd to raise the other is very little more, than what surmounts the Friction of the moving Parts ; which renders this Pump preferable to all other ; for, in the working of them, the nearer they approach a *Vacuum*, the greater is their Labour : But this that I am now describing (under the same Circumstances) is quite contrary.

The bottom of the Barrels are plac'd in a Brass dish, represented by *dd*, whose sides are about two Inches high, and is on purpose to put Water in, to keep the Leather Collars (on which the Brass Cylinders stand) moist, whereby the Air is prevented from insinuating into the Cylinders in those Parts. The Cylinders are screw'd down on the same by the Nuts *eeee*, which force the Frontispiece *ff* down on them, thro' which the two Pillars *gggg* pass : The Pillars have an Iron belonging to each of 'em, and pass from 'em in the form of a Swan's Neck, decipher'd by *gg*, which Irons are fasten'd to the hinder part of the Frame, for their better security from shaking.

From between the two Brass Barrels arises a Brass hollow Wire, *bbbb*, which hath a Communication with each of 'em, by means of a perforated piece of Brass, which lies along horizontally from one to the other. The upper end of this hollow Wire is fasten'd to another piece of perforated Brass, which screws on underneath the Plate *iiii*, which is ten Inches over, and has a Brass Rim solder'd on it, to prevent the shedding of Water; for which there is occasion in several Experiments. Between the middle and the side of this Plate arises a small Pipe, *k*, about an Inch and half in height, thro' which into the fore-mention'd hollow Wire passes all the Air into the Barrels, as it is taken from the exhausting Receiver. Upon the Plate of the Pump is always laid a wet Leather, on which the Recipients are plac'd:

This

This wet Leather prevents the Air's getting into the Glasses, whose edges are truly ground, and is of use for that purpose beyond any Cement whatsoever, and not only secures it from the Air's ingress that way, but by the use of it we can make several Experiments in the same time they formerly cou'd make one, without any daubing or difficulty. Another Excellency in this Pump is, the Contrivance of the Gage, denoted by *llll*, which Gage is a Glass Tube about 34 Inches long, and is so plac'd that it cannot easily receive damage, and is altogether out of the way of any thing that is experimented on the Pump.

Its lower Orifice is plung'd in a Glass of *Mercury* describ'd by *mm*, on the surface of which is laid a piece of Cork with a hole in the middle for the Glass Tube to pass through: On this Cork is plac'd a Board made of *Box Wood*, about an Inch in breadth, and groov'd in the middle to receive the fore-mention'd Glass Tube, which is loosely loop'd on to the same by two Brass Loops, that it may have the Liberty of rising and falling as the *Mercury* ascends or descends in the Gage. To the upper Part of this Tube is cemented, a Brass Head, which Brass Head fits into the fore-mention'd perforated Brass Piece, that is screw'd on under the Plate, and has a Communication, as well with the Recipient on the same, as with the hollow Brass Wire *hhhh* passing between the two Barrels. The Box Board is graduated into Inches and Quarters, from the surface of the Quick-silver to 28 Inches high: From thence 'tis divided into Tenths of Inches.

By this Gage the degrees of Rarefaction in any Experiment, are at all times most nicely to be observ'd. The Air-Cock, *n*, which lets in the Air, is likewise a screw on the same fore-mention'd perforated Brass, in which the upper Parts of the Gage and hollow



hollow Wire are inserted: o o o o represents a Receiver standing on the Plate of the Pump, on whose upper Part p p, thro' a Box of Collars of Leather, passes a Slip-wire, whose Office is to take up, let fall, or suspend any Thing at any determinate height, in the Receiver, without the Air's Insinuation.

Thus far Mr. Hawksbee has describ'd the Pump; which I hope I have since improv'd by a Contrivance, whereby in turning the Winch quite round, the Emboli or Pistons are alternately rais'd and depress'd; whereas in Mr. Hawksbee's way, the moving of the Hand backward and forward is not only more troublesome, but shakes the Pump; because it is requir'd to press the Pistons hard against the bottom piece under the Barrels to discharge the Water from the Valves at every stroke. Besides, if the Pump shou'd at any time happen to leak, when an Experiment shou'd be made in haste; you may exhaust so fast this Way, as to make your Experiment without being at the trouble to pull the Pump to pieces in order to make it tight; except in such Cases, as require the Recipient to be perfectly exhausted.

---

The Description of the Machine for giving a swift Motion to Bodies in Vacuo, without admitting the External Air; represented by Plate II.

**A** A A A is a Ladder, such as is generally us'd in Houses.

B B is a Bar of Iron, which passes through the middle of the upper Step, and is fasten'd to the Back-board of the Ladder by two Nuts and Screws thro' both the Board and Iron.

CC

*CC* the Jaws of the Iron Frame, which holds the great Wheel *DD*, of 23 Inches Diameter with its Groove.

*EE* the Brass Plate of the *Air-Pump*, on which the Recipient *FF* is plac'd.

*GG* the Spindle, to which Bodies of different Magnitudes may be fasten'd, by a hole passing thro' the middle of them, sufficient to receive the Spindle; and by means of the two Nuts *HH*, a larger or a smaller Body may be screw'd fast on.

*II* is a Brass Plate turn'd true to the ground Edge of the Recipient on which it is plac'd, having a Brass Box in the middle of it, which is full of Collars of Leather well oyl'd, thro' which the Spindle passes; the hole of the Brass being likewise just fit to receive it.

*KKKK* Two Pillars, with Nuts to screw down a piece of Board, which has an Iron fasten'd to it to receive the upper Point of the Spindle; the lower one falling into a Brass Socket, screw'd to the middle of the Plate of the *Air-Pump*.

*LLLL* the Supporters, reaching from the upper Board of the Ladder to the Pillars, to prevent the Recipient's being drawn from its Place by the Motion and Tug of the Wheel-band.

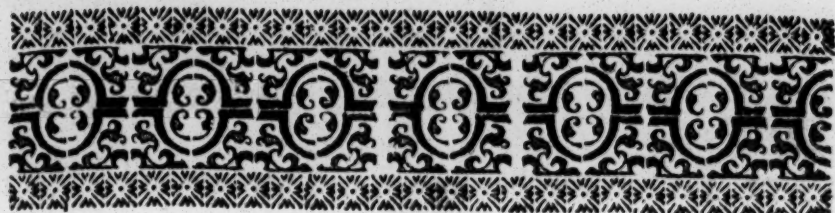
*NN* the Winch which gives Motion to the whole; the small Wheel *MM* making about fifteen Revolutions to one of the large Wheel *DD*; so that a Body fasten'd to the Spindle *GG*, of the small Wheel *MM*, will be turn'd fifteen times round to once of the great Wheel: And according as that shall exceed in Diameter the small Wheel, so will the velocity of the Motion of the extreme Parts be proportionably encreas'd.

*OOOO* a strong Board reaching from the lower Jaw of the Machine to the Ground, for the support, or giving a steady motion to the great Wheel.

*PP* are two Screws, which fasten the Ladder to the Floor.

EX-





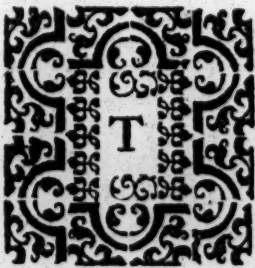
# EXPERIMENTS

To be made on the

## AIR-PUMP.

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EXPERIMENTS *to shew the  
Expansion of the Air, by its  
Spring or Elasticity.*

1.  TAKE a Bladder and squeeze out the Air, so as to leave only what remains in the Folds of the Bladder, then tie it close and seal it, so that the Air cannot escape.

Lay the Bladder on the Air-Pump, and set a Receiver over it, then exhaust the Receiver, and the Air in the Bladder will expand it self so as to blow up the Bladder; when you let in the Air, the Bladder will return to its former Shape: Which shews  
B the

the Expansion of the Air by its Spring or Elasticity. *Plate 3. Fig. 1.*

2. To know how much the Air expands it self, Take a Glas Bubble, of about an Inch Diameter, with a Stem of about six or eight Inches, fill it almost all full of Water, except a very small Bubble of Air; then inverting this Bubble or Bolt-Head into a Jar of Water, cover the whole with a Receiver, which exhausts, and the little Bubble of Air will expand it self: So that by comparing the Bigness of the said Bubble of Air as it was at first, to its Bigness when expanded, you will know the Proportion of the Expansion of the Air. *Plate 3. Fig. 2.*

3. Take an Egg and break off evenly about a third Part of the Shell at the little End, and put the Yolk and White out of the Shell, and at the Bottom you will see a small Bubble of Air, which lies between the Skin and the Shell; set the Egg up in some little open Glas on the Pump, and put a small Receiver over it, and when you exhaust the Receiver, the Air in the Shell will expand it self, and raise up the Skin, so as to fill the Shell, and appear like a whole Egg. Or take an Egg and make a small Hole in the little End, and invert it in a small Glas, and set it on the Plate, and set a Receiver over it, and when you exhaust



( 3 )

haust the Receiver, the Air in the Bubble will expand it self, so as to force all the Egg out of the Shell through the Hole in the End; then let in the Air, and if the Shell be kept down, it will all return again into the Shell; which likewise shews the Expansion of the Air by its Spring. *Plate 3. Fig. 3.*

4. Take the Flint-Glass-Bottle with the Brass Head, and put a little Mercury in the Bottom, then take the Tube which is made for that Purpose, and screw it into the Hole, so that the End may almost touch the Bottom of the Bottle; then setting the Receiver with the large Tube, to cover the small one over Bottle and Tube, as you exhaust it you will see the Mercury rise in the Tube, according to the Expansion of the Air in the Bottle, which (when the Receiver is quite exhausted) will stand at the Height of the Mercury in the common Barometer.

*N. B. If you compare the Height of the Mercury in the Gage under the Pump, with the Height of the Mercury in the Tube of the Bottle abovesaid, they will appear to be of the same Height, which shews that the Spring of the Air is just equal to the Pressure of the Atmosphere. Plate 3. Fig. 4.*

5. Take Glass Bubbles and hollow Glass Images, so far fill'd with Water as to make

them sink in a Jar of Water, the whole being set under a Receiver; and upon drawing out the Air the Bubbles and Images will rise up to the Top of the Water, but sink down again as you let in the Air. *Plate 3. Fig. 5.*

6. The same Experiment may be made by a Bladder half fill'd with Air, and just sunk with Weights.

7. Take a Bladder and squeeze out some of the Air, so that it will go into a wooden Cylindrick Box, then lay a Plate of Brass over the Bladder, and screw a Wire into the middle of the Plate, about 9 Inches high, lay on that Plate Lead Weights, of what Weight you please, with Holes in the Middle to receive the Wire; put it on the Pump with a large Receiver over it all, then the Receiver being open at the Top, lay on a wet Leather and a Plate of Brass, with a Piece of hollow Wire in the Middle to receive the Wire in the other Plate, and to go also into the Holes of the Weights; then exhaust the Receiver, and the Air in the Bladder will expand it self, and raise up the Weights, though you have above forty Pounds; then let in the Air, and the Weights will come down as before. *Plate 3. Fig. 6.*

8. Take a small Tube, about five Inches long, and cement it into a Brass Screw, which



which will fix it to the Bottle which you use for raising the Mercury, then tie a small Bladder upon the End of the Tube which goes into the Bottle, and seal it tight, so that the Air cannot escape any where but through the Tube ; squeeze the Bladder together, and having put it through the Screw-Hole into the Bottle, screw the Brass Screw with a Leather upon it, tight into the Bottle, having first blown up the Bladder within the Bottle before you fix the Screw, so make it tight with a Key, and set the Machine on the Pump with a Receiver over it ; when you begin to exhaust, the Air in the Bottle will expand it self, and press the Bladder together, which shews how the Lungs of an Animal *in Vacuo* are pressed together by the Expansion of the Air in the *Thorax*, because the Lungs having a Correspondence with the Receiver through the Wind-Pipe, have no Air in them in such a Case, to keep up the Lungs against the Expansion of the Air in the Cavity of the *Thorax*, which presses against the Outside of the Lungs ; as the Air in the Bottle in this Experiment causes the contain'd Bladder to subside *in Vacuo*. Plate 3. Fig. 7.

9. *Cats* or other Animals die *in Vacuo*, if the Air is not let in again very soon.

10. *Fishes*

10. Fishes put in a Jar of Water under a Receiver, will (when the Receiver is exhausted) rise up to the Top of the Water, without being able to go down to the Bottom, because the Air in their Wind-Bladder being expanded against their Will, makes them specifically lighter than Water: Sometimes the Bladder breaks, and then they sink down to the Bottom, whence they can rise no more. N. B. Fishes, Frogs, *and other Animals that live in the Water, will not die by exhausting the Air from the Receiver.*


11. Take a square Viol, and put in a Cork, then seal it so that no Air can escape, and put it into a Cage of Wire ; then set it on the Pump with a Receiver over it, and when you begin to exhaust, the Air in the Bottle will expand it self so as to break it. When you have made this Experiment, wipe the Leather and your Pump-Plate, so that none of the Glafs remain, for it may spoil another Experiment. *Plate 3. Fig. 8.*

12. The same Experiment is to be made with the Bottle and Cage under Water, in which Case the Shock will be so great as to shake the whole Pump. *Plate 3. Fig. 9.*

*Expe-*



*Experiments to shew the SPRING  
of the AIR in the Pores of  
Bodies.*

13.  TAKE an Apple, as much shrivelled as can be had, and lay it on the Pump, set a Receiver over it, as you exhaust the Receiver the Apple will appear as smooth as one fresh gathered, let in the Air and it will return to its former Shape.

14. Take a small Jar or Cup, and fill it almost full of Small Beer, then taste it and set it on the Pump, and put a Receiver over it, and when you exhaust the Receiver, the Air in the Beer will expand it self, and cause the Beer to rise up in a Froth, so as to come quite over the Glass: Then let in the Air and taste the Beer, and you will find it quite dead.

15. Take a small Jar or Cup, and fill it with luke-warm Water, and set it on the Pump with a Receiver over it, and when you exhaust the Receiver, the Air in the Water will expand it self, and raise large Bubbles, so that the Water which was luke-warm will seem to boil, and diffuse its Heat so as to warm the Receiver all over ;

ver; then let in the Air, and it will immediately cease to bubble.

16. Take a Piece of Cork, and fix to it a Piece of Lead, so as to poise the Cork, that it will but just sink in Water, then take a Glafs Jar full of Water, and put in the Cork and Lead, which set on the Pump with a Receiver over it, and when you begin to exhaust, the Air in the Pores of the Cork will expand it self so as to swell the Cork, which therefore becoming lighter than an equal Bulk of Water, will rise up to the Surface; then let in the Air, and the Cork will sink to the Bottom again. *Plate 3. Fig. 10.*


17. Take boil'd Water, and after having drawn as much Air out of it, as can be done by the Pump, put a Piece of raw Flesh into the Water, and you will find that upon pumping out of the Air, that Air that was contain'd in the Flesh will extricate it self in Time, bubbling up through the Water.

N. B. *There is Air in Blood and all Animal Fluids.*

*Expe-*



## *Experiments to shew the PRESSURE of the AIR.*

18.  TAKE a Glass open at both Ends, of about two Inches Diameter, and of what Height you please, set it on the Pump, then lay on your Hand so as to cover the Glass, then begin to exhaust, and you will feel the Pressure of the Air; for the Air being taken from under your Hand out of the Glass, the external Air will press your Hand to the Glass, so that you can scarcely move it; upon letting in the Air, it will be loosen'd again.

*N. B. The Spring of the Air in your Flesh is also shewn by this Experiment, the Flesh of the inside of your Hand swelling downward within the exhausted Glass.*

19. Take a Glass which is open at both Ends, then take a Bladder and wet it well, stretch it over the largest End of the Glass, which must be at least four Inches wide, then tye it and let it dry on, and when it is dry, set it on the Air Pump, with the Bladder uppermost; then exhaust the Glass, and the external Air will break the Bladder with a large Report. *Plate 3. Fig. 11.*

C

20. Take

20. Take a Piece of common Window-Glass, and lay it upon the Mouth of a Receiver, or Brass Ferril, and set it on the Air Pump ; exhaust the Receiver, or Brass Ferril, and the external Air will break the Glass all to Pieces, in the same Manner as the Bladder in the other Experiment.

21. Take a square Bottle and cement on a Cap of Brass, with a Place for a Valve, then tie a small Piece of wet Bladder over the Hole, so that the Air can come out, but cannot return the same Way ; then put it in the Cage of Wire, and set it on the Air-Pump with a Receiver over it, and when you exhaust the Receiver, the Air in the Bottle will come out through the Valve: When you have quite exhausted the Receiver, then let in the Air on the sudden, which not being able to get into the Bottle, because of the Valve, it will break the Bottle all to Pieces. *Plate 3. Fig. 12.*

22. Take a Couple of Brass Hemispheres, and set them upon one another, with a wet Leather (which has a Hole in the Middle) in Order to make them tight, and having screw'd a Cock into one of them, fix it to the Pump by Means of a double Male Screw, always observing to have oil'd Leather between the Screws ; when you have exhausted the Hemispheres, turn the Cock so shut their Communication with the Pump :



Pump: Take off the Hemispheres, and they will stick so fast as to require a great Force to pull them asunder, about 140 Pound; if their Diameter be equal to  $3\frac{1}{2}$  Inches, and proportionably more or less according to their Diameters, the Weight requir'd to draw them asunder being greater or less, just as the Square of the Diameters of the Hemispheres is greater or less than the Square of three Inches and a half, in which Case the Weight is 140 Pound.

N. B. *You must screw two Rings to the exhausted Hemispheres, and draw them asunder with a strong Steelyard.*

The exhausted Hemispheres will fall asunder of themselves in *Vacuo*, if you fix the uppermost to the Hook of the slip Wire before you exhaust. In the 13 *Fig. of Plate 3.* you see the Hemispheres exhausted in *Vacuo*, the wooden Dish made use of for the Bladder, in the 7th Experiment, being set under to receive the falling Hemisphere, lest it should damage the Glass.

23. Take the Plate of your *Transferrer* (which is a six Inch Plate) and having by Means of its Cock fix'd it to the Pump, screw a spouting Tube to the upper Part of it, at the End of the Cock's Screw, which comes through the Plate. Put a wet Leather upon the Plate, and then set upon it the tallest Receiver you have. Exhaust it,

and having turn'd the Cock, take it off of the Pump. Hold this exhausted Machine over a Bason of Water, and having put the Mouth of the Cock under Water, open the Cock, and the Atmosphere will by its Pressure, force the Water up into the evacuated Receiver, making a pleasant Fountain. *Plate 3. Fig. 14.*

24. Having exhausted the tall Receiver above mention'd, and taken it from the Pump, take a pretty large Glafs Fountain, or Brass one, with its Force-Pipe screw'd into it, but without its *Ajutage* (or spouting-Pipe) let this Fountain be half full of Water (no Air being condens'd over the Water) and having screw'd the Cock of the Plate to it, turn the Cock, and the Air in the Fountain will by its Spring press so hard upon the Water under it, as to cause it to rise through the Force-Pipe quite into the exhausted Receiver, spouting up in a pleasant Manner as before. *Plate 3. Fig. 15.*

25. Take a pretty tall open Receiver, and having set a Gally-pot half full of Mercury upon the Plate of the Pump, take the four Inch Plate and screw it to the Glafs Tube that has a double Male Screw fasten'd to the End of it, so that when the Plate (with a wet Leather under it) is set upon the Receiver, the End of the Glafs Tube may



may dip into the Mercury in the Gally Pot. Then screw the little Syringe upon the upper Screw of the said Tube, above the Plate and Receiver. Gently lift up the Piston of the Syringe, and you will see the Mercury rise out of the Gally Pot into the Glas Tube; afterwards exhaust the Receiver as much as you can, and when no Air is left in it, you may then pull the Piston of the Syringe quite up, without sucking any Mercury up the Glas Tube. This shews that all the Phænomena of Suction and Pumps, are not owing to an Abhorrence of a *Vacuum* in Nature; but to the Pressure of Air. *Plate 3. Fig. 16.*

26. Take a Lamp Cupping Glas, and set it on the Pump, with a Receiver (that hath a small Hole in the Top) over it, then exhaust the Receiver, and the Air in the Cupping Glas will expand it self and come out, then let in the Air on the sudden by taking off your Finger, which was held at the Top Hole of the Receiver, and the Cupping Glas will be fast, and the Receiver become loosen'd; put on the Receiver and exhaust again, and the Cupping Glas will be loose, and the Receiver fast as at first, but you must not set the Cupping Glas over the Hole in the Plate, because then you would exhaust that and not the Receiver. This Experiment shews, that what is commonly call'd  
Suction,

Suction, is only the Pressure of Air, which fastens the Cupping Glass by striking against the outside of it, before it can get under it. *Plate 3. Fig. 17.*

27. Take two *Glass-Bubble Fountains* (that is, Glass Bubbles of about two Inches Diameter, with a Tube so cemented in the Neck of each of them, that one End almost touches the Bubble on the inside, and the other End, without the Bubble, is almost all shut up but a small Pin-Hole) and invert the One into a little Jar of Water, and the other into a Jar of Mercury; then setting all under a Receiver, upon exhausting it, the Air will by its Expansion come out of the Fountains, through the Water and Mercury. As you let in the Air again, it will force up those Fluids into their respective Fountains; which being afterwards set with the right End upwards in a tall Receiver, will, upon exhausting it, make Jets of Water and of Mercury, by the Spring of the Air above the Mercury or Water, in the Bubbles. N. B. *You must not quite exhaust the first Receiver, lest too much Mercury or Water should be forc'd into the Fountain.* *Plate 3: Fig. 18, 19.*

28. Take a common Barometer Tube, and fill it with Mercury, and invert it in a little Mercury in a Cup or Jar, then set it on the Air-Pump, and set a Receiver over it,



it, open at the Top, then lay a wet Leather on the Top of the Glass, and take the large Tube, mention'd in the fourth Experiment, with a Cap and a Plate cemented on at the one End, hermetically seal'd at the other, and put it over the other Tube with the Mercury, so as to be tight with the Receiver ; then begin to exhaust, and the Mercury in the inner Tube will come down in the same Proportion as that in the Gage rises. If your Pump be tight, you may bring it quite down, so as to be even with the Surface of the other Mercury. Then let in the Air very gently, for if you let it in too fast, you will endanger breaking the Tube, and spoil the Experiment.





29. Take two Pieces of Marble, Planes of Glass, or Plates of Brass well-polish'd, then put a little Oil between 'em, to keep them from admitting the Air between them, and the lowest Marble will stick so fast to the uppermost, as to hold a considerable Weight ; then take a Receiver, open at both Ends, and set it on the Air-Pump, lay a wet Leather on the Top thereof, and take the Brass Plate, with the Collar of Leathers and Slip Wire, and screw on a Hook, put the Plate upon the Top of the Glass, and hang on the Marbles or Plates on the Hook within the Glass, then exhaust the Receiver, and they will drop asunder ; then  
let

let down the upper Piece just upon the under, and let in the Air on the sudden, and then the Marbles when taken out of the Glass, will bear more Weight than before, when you had put them together with your Hands. The same Receiver, Plate, and Wire will serve, as us'd in the 22d Experiment. *Plate 3. Fig. 13.*

30. Take a small Syringe, with a Lead Weight at the Bottom, then take a tall Glass, and set it on the Air-Pump, and lay a wet Leather on the Mouth thereof, then take the three Inch Plate with the Collar of Leathers, and Wire, and screw the End of the Wire into the Top of the Syringe, which put within the Glass, with the Lead Weight at the Bottom; then exhaust the Glass, and the Weight will come down with the Barrel of the Syringe, because the Air being taken out of the Receiver, which press'd upon the Piston of the Syringe, the Weight becomes too heavy for the Friction of the Piston's Leather against the Sides of the Syringe, and not being resisted by the Air, it must by Consequence come down; let in the Air and the Weight rising again will return to its former State. *Plate 3. Fig. 20.*



# MISCELLANEOUS EXPERIMENTS.

31.     TAKE a middle-siz'd Glass, wipe it well, and set it on the Plate, then begin to exhaust a little, and hold a Candle on the other Side, and you will see a *Halo* about the Candle, or several Colours in the Glass, which will be seen only when the Glass is first exhausting, for when the Glass is quite exhausted, the Colours are all lost. But if you let in the Air, and begin to exhaust, you will see the Colours as before, which may be repeated as often as you please. *Plate 3. Fig. 21.*

32. Take a tall Glass, set it on the Air-Pump, and lay a wet Leather on the Mouth thereof, then take the three Inch Plate, with the Collar of Leathers and Wire, and screw on the Brass Springs with the Flap at Bottom, and a Slip-Plate to open the Spring when *in Vacuo*: Screw the Slip-Plate to the Wire, then put a Piece of Gold, or what Metal you please with a Feather or a Bit of Paper, upon the Flap of the Springs under the Slip-Plate, and exhaust the Receiver quite. Then looking into the Receiver at Bottom, pull the Wire to open the Springs, and let fall the Gold and Feather, which  
D will

will come just at the same Time to the Bottom, because the Air being taken away, which made the Resistance, all Bodies fall equally fast. *Plate 3. Fig. 22.*

33. Set your Bell upon the Plate of the Pump, and cover it with a middle-siz'd Receiver, then shake the Pump and take Notice of the Sound of the Bell. Exhaust the Air and you will not hear the Sound *in Vacuo*, though the Clapper is made to strike the Side of the Bell.

34. Set a lighted Candle in your tallest Receiver, and a few Exsuctions will cause the Candle to go out. The Smoak of the Candle will then lie at the Top of the Receiver, but when you have pump'd out all the Air, it will fall down. This shews that the Smoak does not rise, because it is positively light; but only because it was specifically lighter (or less heavy) than Air.

35. A Piece of lighted Charcoal, fix'd by a Wire to the Brass Hook belonging to the Collar of Leathers, so as to suspend it in a Receiver, will go out *in Vacuo*.

36. When you wou'd fire Gun-Powder *in Vacuo*, take a Gally Pot, and inverting it, set the Gun-Powder Iron (that you have with the Pump) upon the Pot, having first made it red hot. Cover it with your Gun-Powder Receiver (which must be first warm'd by Degrees, lest the Heat of the Iron should crack it) and having exhausted it,



it, by moving the Slip of Wire up and down, you will let fall a small Quantity of Gun-Powder upon the hot Iron, where it will fire, Corn by Corn. When you let in the Air again, let it be by little and little, lest you crack the Receiver.

N. B. *After every Explosion exhaust the Receiver, because the Gun-Powder generates Air, and might at last burst the Receiver.* Plate 3. Fig. 23.

37. If you would preserve Fruit, Flowers, or any Thing else *in Vacuo*, fix the Plate of your Transferrer by its Hook to the Pump Plate on which you may lay your Fruit in a Jar: Cover the whole with a Receiver, that stands on the Transferrer with a wet Leather under it. After Exhaustion take off the Receiver, as is mention'd in the 24th Experiment, and keep it as long as you will, having screw'd the Cock to its wooden Foot. If you would prevent the least Air from coming in, put the whole Machine under Water, and keep it so. Plate 3. Fig. 24.

38. Take the Steel Plate which is fix'd on the Spindle, with the Nuts belonging to the Machine for the Attrition of Bodies *in Vacuo*, (*which is represented in Plate 2.*) and having screw'd the Brass Springs with the Flint tied to it, so as to press the Edge of it against the Steel, let the Spindle pass through the Collar of Leathers of the Plate, which

covers the large Receiver, that is set over the Flint and Steel : Put the Pulley and String upon the Spindle, and screw down the Board with the Center Hole cross the Pillars ; then turn the great Wheel to give a Motion to the Steel Plate against the Flint, which will produce many Sparks ; but as you exhaust the Receiver, the Sparks will diminish and quite vanish when all the Air is drawn out, though the same violent Motion is continu'd. *Plate 3. Fig. 25.* represents the Brass Springs with the Flint fix'd to them, and the Hole to screw in the Center Plate for the Spindle to turn upon. The same Figure also represents the Spindle and Pulley, with the Steel Plate and Nuts in the Middle.

39. Soap'd Water will rise into large Bubbles *in Vacuo*, upon which you will see several Colours succeed each other ; and the Skin of Water, when extremely thin, will be black.

40. With a Piece of solid Phosphorus write upon a Paper, and laying it upon the Plate of the Pump with another Paper under (least you wet the first Paper) draw out the Air, and the Phosphorus will brighten by Degrees, and at last throw up a lucid Cloud to the Top of the Receiver. N. B. *The Room must be dark for such kind of Experiments.*

41. If you wet the Paper by Patches on which you have drawn Lines with Phosphorus, instead of a Cloud, it will give Flashes *in Vacuo*.

42. Take the Receiver used for the Guinea and Feather Experiment, and to the Brass Plate, used to cover it, screw a large Cupping-Glass with a Tube cemented to its Neck, with a fine Hole in it (so as to make a Funnel) and having stopt the Hole of the Neck of the said Cupping Glass with a wooden Plug, fill it with Mercury. Under the Receiver have another tall one of an arch'd Figure without a Knob at Top, as in *Plate 3. Fig. 25*. Then having drawn out the Air from both Glasses, take out the wooden Plug, and the Weight of the external Air will force the Mercury in a Shower upon the inward Glass, so as to produce a great Light in a dark Room, if the Mercury be fine, and the Weather very dry, otherwise the Experiment will not succeed.

43. Having cemented an open Tube, ending in a Point, to a Brass Stop-Cock, put it through the Brass Plate that covers an open Receiver, so that the Tube shall reach down half an Inch below the Surface of about a Pound or two of Mercury in a Glass Jar under the Receiver. Shut the Cock, then exhaust the Receiver, and then opening the Cock, the Air will rush in, through the Mercury, so as to throw it in little  
Ball



Balls all over the Glafs, and produce a fiery Shower, visible in a dark Room if the Weather be dry. *Plate 3. Fig. 26.*

44. Having exhausted a Receiver, let in the Air again at Top, through an Iron Tube (or Brass Tube whose End is screw'd to an Iron one) so that it may pass through the Flame of Charcoal, before it goes into the Receiver; and when the Receiver is full of that Air, lift up the Cover of the Receiver, and letting down an Animal into the Glafs, you will find that this infected Air will kill him immediately. If the End of the Tube be thrust into the Hole of a solid Piece of red hot Brass, which is not perforated quite through, the Air which must come into the Tube, will in its Way, carry along with it the *Effluvia* of the Brass, which will poison the Air, but not so much as before, an Animal being longer a dying in this than in the last Medium. If a Candle be let down into the Receiver, when fill'd with this Air, it will go out, but purge the Air as far as it goes; for you may let it down the second Time lower than the first, and so on, till the whole Air be purify'd. N.B. Air burn'd in going through red hot Iron or Copper, is not pernicious to a very tender Bird, or any Animal, that it has been try'd upon. See *Plate 3. Fig. 27.*

45. To an equal (but small) Quantity of Oil of Vitrtol, Oil of Tártar *per Deliquium*,

*quium*, and Oil of Cloves, put two or three small Pieces of Phosphorus, and this Mixture will take Fire in the open Air, but the Addition of a little common Water will put it out. This Preparation will not only shine, but boil up into a Flame, in the exhausted Receiver.

46. If you would weigh any Quantity of Air, take a pretty large Copper or Glass Ball, such as Fountains by (Compression of Air upon Water) are made of, and having, by means of a Cock fix'd it to the Female Screw in the Plate of your Air-Pump, exhaust it; shut the Cock, and having taken off this exhausted Ball, hang it at one End of the Beam of a Pair of Scales; counterpoise it at the other End; then let in the Air into the Ball, by opening the Cock, and the Ball will preponderate: So much Weight being requir'd to restore the *Æquilibrium*, as answers to the Weight of the Air contain'd in the Ball above-mention'd. *Plate 3. Fig. 28.*

47. To the slip Wire of the Collar of Leathers, at the Top of a Receiver, fix a Piece of Cork, with several small Tubes going through it, and having set a Jar with coloured Water in it, under the Receiver, pump out the Air, then by pushing down the slip Wire, plunge the Ends of the small Tubes into the coloured Water, and it will rise as high in those Tubes as it does in open Air. *See Plate 2. Fig. 3.* 48.

48. Take a Vessel of Brass, like a Funnel, or truncated Cone, open at both Ends, made so that the Hole at one End is not above  $1\frac{1}{2}$  Inch Diameter, and the other End almost 4 Inches. Set this truncated Cone upon the Receiver with the small Hole upwards, and having laid a Piece of flat Window Glass upon it, exhaust the Air, and the Glass will not break: Let in the Air again, and laying the same Piece of Glass upon the larger Orifice of the Brass Vessel, as soon as you have drawn out the Air, it will break, which shews the Pressure of the Air is proportionable to the Surface on which it presses. The Brass truncated Cone is shewn by Fig. 29. Plate 3.

49. Flies will not die, but be unable to fly *in Vacuo*.

50. Take a Piece of Wood with a little Hollow in it, like a round Trencher, and weigh it, then having laid some Mercury, in the said Hollow, cover it with a Receiver, and when you have drawn out and again let in the Air, you will find the Wood much heavier than it was, the Air having press'd a great deal of the Mercury into the Pores of the Wood. Plate 3. Fig. 30.

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